"The Living Soil"

Correlation to the 2012 NC Essential Standards

~ S C I E N C E ~

Kindergarten

Forces and Motion

K.P.1 Understand the positions and motions of objects and organisms observed in the environment.

K.P.1 Compare the relative position of various objects observed in the classroom and <u>outside</u> using position words: above, behind, below, beside, between, in front of, on top of, under.

K.P.1.2 Give examples of different ways objects and organisms move: straight, zigzag, round and round, back and forth, fast and slow.

While exploring the living soil collected from their backyards or outdoors on their school grounds, students look for all kinds of soil organisms and observe them closely. Students use descriptive words to describe how the soil animals move. Students use position words to describe where soil animals are located in the soil. To show their understanding of different ways organisms move, students imitate soil animals' movements by physically moving their body the same way: centipedes move fast, millipedes move slow, roly-polies roll up into a ball and can roll round and round, while some soil animals dart in a zigzag and others go straight, and ants go back and forth from their ant hill. To show their understanding of the relative position of organisms in the soil, students move their bodies and describe where a soil animal is: there are lots of animals above the ground but many, many more animals below ground, beetle larvae lie between the roots that they eat, snails and slugs eat living plant leaves on top of the soil, and earwigs hide behind bark and leaves.

Matter: Properties and Change

K.P.2 Understand how objects are described based on their physical properties and how they are used.

K.P.2.1 Classify objects by observable physical properties: size, color, shape, texture, weight & flexibility.

K.P.2.2 Compare the observable physical properties of different kinds of materials (clay, wood, cloth, paper, etc.) from which objects are made and how they are used.

While exploring the living soil, have students look for seeds that come in a variety of sizes, shapes, colors, weights, and degrees of flexibility. Seeds are used to produce new plants of the same kind. The seeds in the soil may grow into grasses, wildflowers, shrubs, vines, huge trees, and weeds (unwanted plants.) If the school has a food garden, discuss how people plant certain seeds to grow food plants to eat or how they may eat seeds directly like sunflower seeds.

Earth Systems, Structures and Processes

K.E.1 Understand change and observable patterns of weather that occur from day to day and throughout the year.

K.E.1.1 Infer that change is something that happens to many things in the environment based on observations made using one or more of their senses.

K.E.1.2 Summarize daily weather conditions noting changes that occur day to day and throughout the year.

K.E.1.3 Compare weather patterns that occur from season to season.

On their schoolyard, students can explore the living soil throughout the different seasons of the year. Examples: Tree leaves fall to the ground and are eaten by hungry soil organisms and eventually broken down into soil. Spring brings seeds sprouting in the living soil to produce new plants. During rainy weather, students may observe worms moving out of the soil. Earthworms breathe through their skin and will drown if the soil pores fill with too much rainwater. All living organisms in the soil need water, but sometimes nature brings us too much of a good thing! Students may observe that puddles form on the living soil if the soil cannot absorb all the rainwater because it is compacted or saturated.

Kindergarten continued…

Structures and Functions of Living Organisms

K.L.1 Compare characteristics of animals that make them alike and different from other animals and nonliving things.

K.L.1.2 Compare characteristics of living and non-living things in terms of: structure, growth changes, movement, basic needs.

While exploring the living soil, have students observe and compare the living soil organisms with the non-living components of soil. Example: Living soil animals need food for energy so they can grow, develop and reproduce. Soil animals spend their time eating living plants in the soil, or other living animals, or dead plants & animals. Rocks and soil particles are not alive (never were and never will be) and do not require water or food. However, rocks can be broken down into soil particles by water over many, many years (animals grow bigger, but rocks grow smaller!) Soil contains minerals from its parent rock and provides these minerals to the living plants and animals that live in it. Soil plants and animals have similar needs for survival as people do. We depend on the soil and both its living ingredients (plants and animals) and its non-living ingredients (soil particles, pore space filled with air and water, and rich organic matter) to grow our food and filter clean water for us to drink. Healthy soils = healthy people and all living things!

Grade 1

Earth Systems, Structures and Processes

1.E.2 Understand the physical properties of Earth materials that make them useful in different ways.

1.E.2.1 Summarize the physical properties of earth materials, including rocks, minerals, soils and water that make them useful in different ways.

1.E.2.2 Compare the properties of soil samples from different places relating their capacity to retain water, nourish and support the growth of certain plants.

While exploring the living soil, have students compare soil samples and draw pictures of what they observe first with unaided eyes and then with a hand lens or magnifying glass. Have students feel soil samples and identify the different textures of sand, silt and clay. Discuss how clay's malleable properties allow it to be formed into bricks and pottery. Students can experiment by pouring water onto different soil samples and observing which soil drains water quickly and which holds more water for plants to use.

Ecosystems

1.L.1 Understand characteristics of various environments and behaviors of humans that enable plants and animals to survive.

1.L.1.1 Recognize that plants and animals need air, water, light, space, food and shelter and that these may be found in their environment.

1.L.1.2 Give examples of how the needs of different plants and animals can be met by their environments in NC or different places throughout the world.

1.L.1.3 Summarize ways that humans protect their environment and/or improve conditions for the growth of the plants and animals that live there.

While exploring the living soil, emphasize that soil is a living ecosystem and is teeming with plant and animal life. Soil provides all necessary habitat components: air, water, food, shelter, and space in a suitable arrangement. (Only light is missing except at the soil's surface.) In fact, there's more life below ground than above. All life above ground depends on the life below ground. Soils are found in all kinds of environments the world over and it's estimated that there are 70,000 different soils on Earth. Best management practices to improve soils are determined by research, years of application to the land, and effectiveness. We can all apply BMPs—whether on the farm, schoolyard or home backyard—by blanketing our soil and protecting it from over-tillage, compaction, erosion, chemicals, etc. while adding rich organic matter. Soil conservation protects the soil environment and improves conditions for the growth of plants and animals that live there.

Grade 1 continued…

Molecular Biology

1.L.2 Summarize the needs of living organisms for energy and growth.

1.L.2.1 Summarize the basic needs of a variety of different plants (including air, water, nutrients, and light) for energy and growth.

1.L.2.2 Summarize the basic needs of a variety of different animals (including air, water, and food) for energy and growth.

Upon exploring the living soil, students can observe and/or infer that soil provides plants and animals their basic needs for energy and growth. As an important part of photosynthesis, plant roots take up water and dissolved minerals and nutrients from the soil. As plants die and decompose, their nutrients are returned to the soil. As students dig in the soil, help them observe living plant roots and point out mushrooms or fungi obtaining their nutrients by decomposing dead plants (as they have no chlorophyll to make their own food from sunshine energy.) As students dig and discover many different soil macroinvertebrates such as earthworms, roly-polies, millipedes, snails, spiders, beetles, etc., help them understand that all their habitat components for survival are provided by the soil—air, food, water, food, and space in a suitable arrangement—for energy and growth. How do we know? The plants and animals wouldn't be there otherwise!

Grade 2

Earth Systems, Structures and Processes

2.E.1 Understand patterns of weather and factors that affect weather.

2.E.1.1 Summarize how energy from the sun serves as a source of light that warms the land, air and water.

2.E.1.3 Compare weather patterns that occur over time and relate observable patterns to time of day and time of year.

Exploring the living soil, students can take the temperature of the soil (surface and deeper) to determine if sun energy warms the land. This same temperature monitoring can be done throughout the different seasons to see if soil temperature differs in summer, fall, winter and spring. This can also be done in the early morning, high noon, and late afternoon to observe patterns over time of day. Students can observe other weather patterns and how they affect soil on the schoolyard. If there's a negative effect, students can learn about ways to reduce or prevent the weather-related problem (i.e. erosion of bare soil → mulch or anchor permanently with roots of plant native vegetation.)

Structure and Functions of Living Organisms

2.L.1 Understand animal life cycles.

2.L.1.1 Summarize the life cycle of animals including: birth, developing into an adult, reproducing, aging and death.

Exploring the living soil, students may observe soil macroinvertebrates in different life stages in the soil. For example: grubs that are the feeding larval stage of a beetle; ants scurrying to hide their eggs when you disturb their anthill; the "empty" molt of a cicada nymph that had split its exoskeleton to emerge as an adult cicada with wings; dead animals or animal parts found in the soil such as an insect wing, or an ant carrying a dead animal into its burrow.

Evolution and Genetics

2.L.2 Remember that organisms differ from or are similar to their parents based on the characteristics of the organism.

2.L.2.1 Identify ways in which plants and animals closely resemble their parents in observed appearance and ways they are different.

Exploring the living soil, students can observe that some soil macroinvertebrates such as baby roly-polies, millipedes and spiders look like miniature versions of their larger parents, although perhaps a bit lighter in color (especially after molting.) Other soil macroinvertebrates, especially insects, look very different from their parents as they undergo either simple/incomplete metamorphosis: egg → nymph → adult or complete metamorphosis: egg → larva → pupa → adult. The appearance of plant seeds in the soil usually looks very different from the parent plant. For example: an acorn compared to a mature oak tree! Even a small grass seed doesn't look like the parent grass! Watch seeds grow to find out…

Grade 3

Energy: Conservation and Transfer

3.P.3 Recognize how energy can be transferred from one object to another.

3.P.3.2 Recognize that energy can be transferred from a warmer object to a cooler one by contact or at a distance and the cooler object gets warmer.

While exploring the living soil, students learn that decomposers are at work breaking down dead organic matter for their own nourishment and to return nutrients to the soil in an available form for plants. Students can set up a compost pile that will reveal how soil organisms, temperature, air, and water are able to decompose organic waste and enrich soil. (i.e. when microbes--bacteria and fungi—eat and breakdown organic matter in the soil, they give off heat that can be measured in a compost pile.)

Structures and Functions of Living Organisms

3.L.2 Understand how plants survive in their environments.

3.L.2.1 Remember the function of the following plant structures as it relates to the survival of plants in their environments: Roots – absorb nutrients, Stems – provide support, Leaves – synthesize food, and Flowers – attract pollinators and produce seeds for reproduction.

Upon exploring the living soil, students learn that plant roots function as "straws" to draw up water and dissolved minerals and nutrients, while also anchoring the plant and the soil in place. At learning stations, students can discover the importance of roots to plants, soil and people (we eat roots like carrots to obtain healthful nutrients.)

3.L.2.2 Explain how environmental conditions determine how well plants survive and grow.

While exploring the living soil, students can compare plants growing in a soil with high organic matter to those growing in a soil with low organic matter. Other conditions to compare would be the amount of soil moisture and its impact on plant growth. How about the visible number and diversity of macroinvertebrates in soils and how this impacts plant growth?!

With regards to soils and severe weather…during heavy storm events such as hurricanes, large oak trees fell over when saturated clay soils could no longer anchor the oak's shallow roots in place.

3.L.2.3 Summarize the distinct stages of the life cycle of seed plants.

While exploring the living soil, students can experiment by monitoring any seeds found and observing & recording their growth over time. Students can collect, sort, and plant outdoor seeds to discover seeds come in a variety of sizes, shapes, and colors, as well as produce plants.

Students can create a class story or storybook about the sequence of plant growth from seed. Students can research the parts of a seed and each part's function during the stages of a seed's growth; then dissect seeds found in the living soil to identify these seed parts.

3.L.2.4 Explain how the basic properties (texture and capacity to hold water) and components (sand, clay and humus) of soil determine the ability of soil to support the growth and survival of many plants.

While exploring the living soil, students can do a myriad of experiments and activities to assess the basic properties and components of their schoolyard soil to determine its plant-growing ability. Students feel soil samples and identify the different textures of sand, silt and clay. Students pour water onto different soil samples and observe which drains water quickly and which holds more water for plants to use. Students see how far down they can push a thin metal rod to test the soil's level of compaction.

Students observe the amount of organic matter in their schoolyard soil and by looking at the health of plants growing on the schoolyard, assess the soil's ability to support the growth and survival of plants.

Grade 4

Earth History

4.E.2 Understand the use of fossils and changes in the surface of the earth as evidence of the history of the Earth and its changing life forms.

4.E.2.3 Give examples of how the surface of the earth changes due to slow processes such as erosion and weathering and rapid processes such as landslides, volcanic eruptions, and earthquakes.

While exploring the living soil, students can construct and perform experiments simulating rain on a field, investigating how soil preparation, tillage techniques, and mulches affect soil erosion and water runoff. Erosion is a natural process, but human activities accelerate the erosion rate to where soils are being lost faster than they are being formed (i.e. it takes 100-500 years for an inch of soil to form.) The loss of topsoil to erosion is the loss of food, water, shelter and space to soil's plant and animal inhabitants. Both soil structure and interactions between the living and nonliving components of the soil ecosystem are enhanced when the soil is undisturbed.

Ecosystems

4.L.1 Understand the effects of environmental changes, adaptations and behaviors that enable animals (including humans) to survive in changing habitats.

4.L.1.1 Give examples of changes in an organism's environment that are beneficial to it and some that are harmful.
4.L.1.2 Explain how animals meet their needs by using behaviors in response to information received from the environment.

While exploring the living soil, students discover that soil is an ecosystem that provides all necessary habitat components for plants and animals—air, water, food, shelter, and space in a suitable arrangement. Highly disturbed soils have less diversity of life and are not as biologically or chemically productive. Undisturbed soils, such as those in no-till fields, harbor a large number and diversity of both macro- and microorganisms that help form and improve soil structure and properties with their constant quest for food, tunneling & burrowing, and decomposing organic matter and converting it to plant-available nutrients.

Concept to convey: Ecosystems rich in biodiversity have greater resiliency to withstand environmental changes.

Some plant roots have a symbiotic relationship with mycorrhizal fungi where the fungi extend their hyphae much further to increase the absorption of water and nutrients, and in return, the plant provides the fungi food in the form of sugar. A win-win!! Some fungal hyphae measure 1 mile to 40 miles in length! Scientists are just beginning to understand the complex interrelationships that take place in the amazing universe right under our feet! Some plant roots can filter contaminated runoff and through plant processes, the contaminants are made less harmful (i.e. bioremediation.)

4.L.1.3 Explain how humans can adapt their behavior to live in changing habitats (e.g. recycling wastes, establishing rain gardens, planting trees and shrubs to prevent flooding and erosion.)

While exploring the living soil, students assess their school ground for excessive stormwater runoff and erosion, research best practices to reduce or prevent erosion, and work with school groundskeepers to be respectful caretakers of their outdoor environment. To protect bare soil, students can use mulch or plant permanent native vegetation that will provide a network of roots to hold soil in place. After researching the need for careful stewardship and the importance of taking personal and collective action, students develop plans to change their own environmental behaviors and that of their class or entire school community.

While exploring the living soil, students can develop mapmaking, map reading, and graph reading skills as they learn the capabilities and limitations of our land resources by using a soil survey. In the process students begin to build a foundation for understanding the complex issues involved in making land use decisions in harmony with the land's capability.

Students can construct and perform experiments simulating rain on a field, investigating how soil preparation, tillage techniques, and mulches affect soil erosion and water runoff.

Grade 4 continued…

Molecular Biology

4.L.2 Understand food and the benefits of vitamins, minerals and exercise.

4.L.2.1 Classify substances as food or non-food items based on their ability to provide energy and materials for survival, growth, and repair of the body.

4.L.2.2 Explain the role of vitamins and minerals, and exercise in maintaining a healthy body.

While exploring the living soil, students can observe that many food chains begin with a plant growing in soil. Concept: Nutrient-rich soils produce nutrient-rich plants. These nutrients are then passed on to herbivores, carnivores, omnivores, and all other consumers. Scientists have discovered that as soil nutrients are depleted with each crop harvest, our food plants contain far less nutrients. Students can experiment with adding organic matter to soil and then comparing plant growth in this enhanced soil versus a soil that lacks organic matter.

Grade 5

Energy: Conservation and Transfer

5.P.3 Explain how the properties of some materials change as a result of heating and cooling.

5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures. (conduction, convection or radiation)

5.P.3.2 Explain how heating and cooling affect materials and how this relates to their purpose and practical applications.

While exploring the living soil, students learn that decomposers are at work breaking down dead organic matter for their own nourishment and to return nutrients to the soil in an available form for plants. Students can set up a compost pile that will reveal how soil organisms, temperature, air, and water are able to decompose organic waste and enrich soil. (i.e. when microbes--bacteria and fungi—eat and breakdown organic matter in the soil, they give off heat that can be measured in a compost pile.)

Mechanisms of Heat Loss (from Cornell University)

The temperature at any point during composting depends on how much heat is being produced by microorganisms, balanced by how much is being lost through conduction, convection, and radiation. Through *conduction*, energy is transferred from atom to atom by direct contact; at the edges of a compost pile, conduction causes heat loss to the surrounding air molecules.

Convection refers to transfer of heat by movement of a fluid such as air or water. When compost gets hot, warm air rises within the system, and the resulting convective currents cause a steady but slow movement of heated air upwards through the compost and out the top. In addition to this natural convection, some composting systems use "forced convection" driven by blowers or fans. This forced air, in some cases triggered by thermostats that indicate when the piles are beginning to get too hot, increases the rates of both conductive and convective heat losses. Much of the energy transfer is in the form of latent heat -- the energy required to evaporate water. You can sometimes see steamy water vapor rising from hot compost piles or windrows.

The third mechanism for heat loss, *radiation*, refers to electromagnetic waves like those that you feel when standing in the sunlight or near a warm fire. Similarly, the warmth generated in a compost pile radiates out into the cooler surrounding air. The smaller the bioreactor or compost pile, the greater the surface area-to-volume ratio, and therefore the larger the degree of heat loss to conduction and radiation. Insulation helps to reduce these losses in small compost bioreactors.

Moisture content affects temperature change in compost; since water has a higher specific heat than most other materials, drier compost mixtures tend to heat up and cool off more quickly than wetter mixtures, providing adequate moisture levels for microbial growth are maintained. The water acts as a kind of thermal flywheel, damping out the changes in temperature as microbial activity ebbs and flows.

Grade 5 continued…

Ecosystems

5.L.2 Understand the interdependence of plants and animals with their ecosystem.

5.L.2.2 Classify the organisms within an ecosystem according to the function they serve: Producers, consumers, or decomposers (biotic factors.)

5.L.2.2 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.

While exploring the living soil ecosystem, students can discover and classify many different plants and macroinvertebrates. Students can research to discern which organisms are producers, consumers, or decomposers. Students can observe and research how living soil organisms are interconnected with each other and with the non-living components of the soil ecosystem (abiotic factors: air, water, heat/temperature, nutrients, minerals.)

Students can trace the sources of their food, clothes, and shelter to learn the interdependence of plants, animals and people.

Students can conduct a composting experiment to learn about the process of decomposition. By building a pile, students can observe how soil organisms, temperature, air, and water are able to decompose organic waste and enrich soil. (i.e. the role of decomposers in cycling nutrients for all living plants and animals in the ecosystem.)

Students can learn about the process of photosynthesis to understand that animals and humans depend on producers such as plants, algae and a few bacteria to capture the sun's radiant energy and transform it into chemical energy that they can consume. And decomposers consume their nutrient energy from dead plants and animals.

Evolution and Genetics

5.L.3 Understand why organisms differ from or are similar to their parents based on the characteristics of the organism.

5.L.3.1 Explain why organisms differ from or are similar to their parents based on the characteristics of the organism.

5.L.3.2 Give examples of likenesses that are inherited and some that are not.

While exploring the living soil, students can research many living organisms that do / do not resemble their parents based on characteristics of the organism. One interesting species is the periodical cicada that lives as a nymph in the soil for 17 years, then emerges as an adult for a brief time to mate and die. What is the survival advantage to this life cycle? What are some popular theories from credible sources? Do you agree or disagree? Why?

Perhaps many soil macroinvertebrates don't resemble their parents because all early life stages are in the soil with different physical and behavioral adaptations needed for this terrestrial environment, versus the adult who has wings and lives above ground flying in the air and seeking shelter in the tree canopy.

###